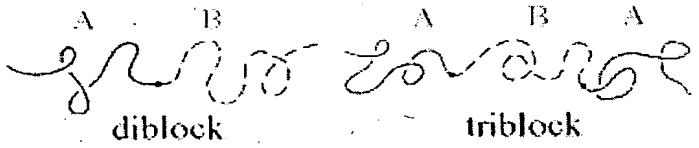
Exhibit B

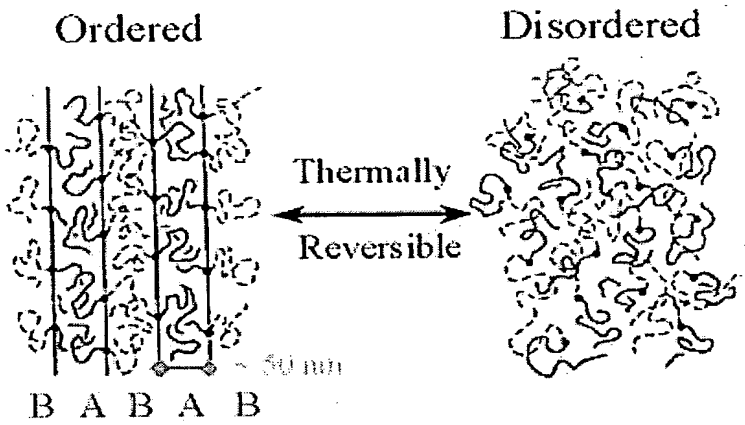
Research

Polymer Research Laboratory

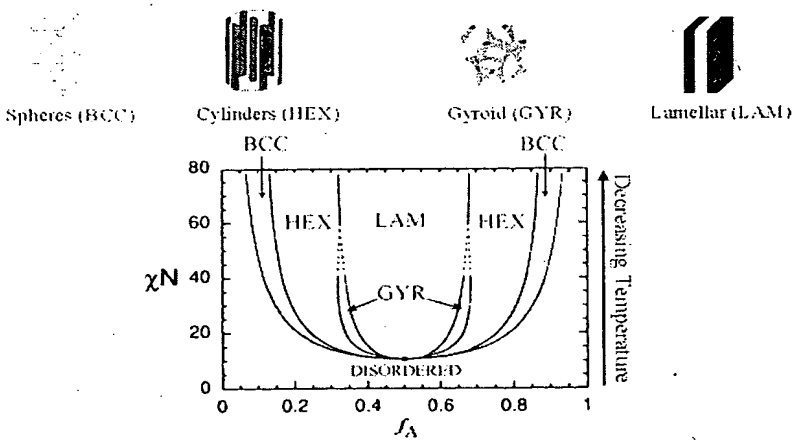
Block Copolymers

Block copolymers are composed of long sequences ("blocks") of the same monomer unit, covalently bound to sequences of unlike type. The blocks can be connected in a variety of ways; schematics of AB diblock and ABA triblock structures are shown below.





The blocks can sometimes intermix freely at sufficiently high temperature, or when sufficiently diluted with solvent, generating the "disordered" structure shown above at right. However, it is common for the blocks to spontaneously self-assemble ("order", as shown above at left) into a diversity of mesophases, with the size scale governed by the chain dimensions (order tens of nanometers). In the mesophases, dissimilar blocks exist in distinct "microdomains" which are highly enriched in blocks of the same type, sometimes to the point of being essentially pure. The covalent bonds linking the dissimilar blocks are thus localized to the vicinity of the microdomain interfaces. While the cartoon above illustrates the case where the A and B blocks are of comparable lengths, the block ratio is easily varied during polymer synthesis to alter the mesophase structure. The known equilibrium mesophases for diblock copolymers (spheres, cylinders, gyroid, and lamellae) are shown in the phase diagram below:



Schematic diblock copolymer phase diagram: ϕ = volume fraction of one block, χ = Flory interaction parameter, N = diblock degree of polymerization. Known equilibrium mesophases are S(pheres), C(ylinders), G(yroid), and L(amellae), as well as the disordered (DIS, homogeneous) state at small interblock segregation strength (χN). Diagram adapted from Matsen and Bates (1996).

In the ordered state, glassy microdomains serve to anchor rubbery segments of the polymer, permitting these materials to be used (at the level of $1 billion/year worldwide) as melt-processible adhesives and rubbers ("thermoplastic elastomers"). Since block copolymers require no vulcanization, they are simpler to process than conventional rubbers and are even recyclable.

Research Projects

- Crystallizable Block Copolymers
- Nanofabrication with Block Copolymers
- Phase Behavior and Rheology